Science Benchmark: 06 :04

The sun is one of billions of stars in the Milky Way Galaxy, that is one of billions of galaxies, and the universe. Scientists use a variety of tools to investigate the nature of stars, galaxies, and the universe. Historically, cultures have observed objects in the sky and understood and used them in various ways.

Standard 04: Students will understand the scale of size, distance between objects, movement, and apparent motion (due to Earth's rotation) of objects in the universe and how cultures have understood, related to and used these objects in the night sky.

Objective 1: Compare the size and distance of objects within systems in the universe.

<u>Activity 1:</u> How Big and How Far

<u>Intended Learning Outcomes:</u>

1-Use science process and thinking skills
2-Manifest scientific attitudes and interests
3-Understand science concepts and principles
4-Communicate effectively using science language and reasoning
5-Demonstrate awareness of social and historical aspects of science
6-Understand the nature of science

Teacher Background:

Students often have misconceptions about the relative sizes of objects in the solar system and the distances between them. Inaccurate commercial models, posters, drawings in books, and science fiction movies perpetuate these errors. One of the best ways to dispel these misconceptions is to give students opportunities to record accurate representations. It is difficult to accurately measure to scale both the size of objects in the solar system and their corresponding distances because of the vastness of the solar system.

There are many activities that could be used for students to measure the accurate sizes of objects and distances between them in the solar system. This lesson describes a scale model activity in detail. Several additional activities are also included in the extensions. Ideally, a combination of activities should be used to help students develop understanding and perspective.

The distances of the planets from the sun can be measured in a variety of ways. Because using miles or kilometers requires calculating with very large numbers, one useful measurement is the astronomical unit or A.U. One astronomical unit is the average distance of Earth from the sun. The distance of the other objects in the solar system from each other can be described in numbers of A.U. For example, Mars is, on average, a little more than 1.5 A.U. from the sun and Jupiter is about 5.2 A.U. from the sun. The A.U. distance from the sun for each planet is found in the "Hansen Planetarium Fact Sheet 2002" (See Appendix).

The diameter of the sun is approximately 109 times larger than the diameter of Earth. By coincidence the distance from the sun to Earth is a little more than 107 times the distance of the sun's diameter, or 107 sun diameters. Earth's diameter is approximately 3.5 times the diameter of the moon. The distance from Earth to the moon is approximately 30 Earth diameters. These ratios are useful in calculating relative size and distance.

Again by coincidence, the distances of the planets from the sun are arranged in a somewhat orderly geometric progression. The Invitation to Learn activity uses the approximate ratios of the distances of the planets from each other to get a quick layout of the solar system.

Materials:
- Cards with the names of the planets and the sun written on them_• Nickels, (at least one per student)
- 90" yellow or orange model of the sun made of craft paper. (To make the model tape together three 90" strips of 36" yellow or orange craft paper. Draw a circle using a string compass made by tying a pencil to a 45" length of string.) Or if you prefer, have students create the sun model (see Step 3).
- Adding machine tape, yarn, string, or other material to measure lengths of 90 inches
- You will need models of the planets to scale with the sun being 90" in diameter. The Earth diameter is represented by the diameter of a nickel (.83" or 2.1 cm in diameter). You may get models of the planets in four ways: (1) Use the chart and make models the size described.

Planet Size with Sun at 90"

Sun	Mercury	Venus	Earth	Mars	Jupiter	Saturn	Uranus	Neptune	Pluto
90 inches	.31 inches	.78 inches	.83 inches	.44 inches	9.27 inches	7.81 inches	3.31 inches	3.21 inches	.15 inches

(2) Use the"Planet Sizes to Scale" images made by the Hansen Planetarium (See Appendix). (3) Have students calculate and create scale models (Use the same models from "Tour of the Solar System" activity). (4) Use the Exploratorium website (see Additional Resources) to calculate the scale sizes and distances of the planets and make the models accordingly (You will enter the sun as 90 inches).

- Local map (optional). One nice way to get a local map is to use the Internet site http://maps.yahoo.com to create a map with your school at the center. This website shows maps using ten zoom magnifications. You will need a map in which the outer limits are 6 miles from your school. You will probably want to make maps at the Zoom-In functions of 2, 3, and 4. You can put your school at the center of the map by adjusting the North, South, East, and West directional arrows.

Invitation to Learn:

Ask for 10 volunteers. Ask the class how many planets are in our solar system. Hand each of the volunteers one of the planet cards. Be sure they are NOT handed out in the order they appear from the sun. Have the person with the sun card stand at one end of the classroom and the person with the Pluto card stand at the other end.

Tell the other eight volunteers to arrange themselves so that the planets are in the correct order. Ask the class if they agree with the order. If there are some errors in their arrangement, carefully rearrange the students so that the planet cards are in the correct order.

Next ask students to arrange the planets in their correct relative distances from the sun. Again have the class debate over the correct relative distances. Rearrange the students so that the cards are in the correct relative distance. Uranus should be about halfway between the sun and Pluto, and Neptune should be halfway between Uranus and Pluto. Saturn is about halfway between Uranus and the sun. Jupiter is about halfway between Saturn and the sun. Earth is about 2/3 of the way from the sun to Mars. Venus is about 3/4 of the way between Earth and the sun. Mercury is about halfway between Venus and the sun.

Instructional Procedure:

In this activity students gain a perspective of how far Earth is from the sun and how large all the planets are relative to each other. Earth is represented by a nickel; the moon by a circle made by a paper punch; and the sun by a circle 90 inches in diameter. An advantage of this model is that the sun is very large on a classroom wall and conveys the enormous size of the sun in comparison with the planets. It also shows the vastness of the distance between the sun and Earth, and the relative closeness of the moon to Earth. Students easily remember the size of Earth as a nickel and the moon as a circle made by a paper punch. Earth's distance from the sun can be located on or near most school playgrounds, and other distant planets are identified by landmarks known to the students or by locating them on a local map.

1. Show students a nickel and explain that this nickel will represent the size of Earth. Ask students to estimate how large the sun would be. Typically, estimates are much smaller than the actual size. Explain the relationship between Earth and the sun's diameter. (One sun diameter is 109 Earth diameters.) Challenge the students to figure out the diameter of the sun using a nickel in the calculation. Have plenty of nickels available for students to use in measuring. A recommendation is to make this a problem-solving experience for the students. One strategy students may want to use is to measure a series of nickels (9 or 10, for example) and use multiples to calculate more efficiently. Give students adding machine tape, yarn, rulers, meter sticks, tape measures, etc., to help solve the problem.
2. Student teams make a single sun diameter using a length of paper strips, string, meter sticks taped together, etc. If teams have varying lengths for the sun's diameter, the class should work together to come up with a consensus. All of the teams should end up with a length of paper, string, etc., that is one sun diameter long. (Each diameter should be about 90 inches long.)

3. Show students the yellow craft-paper sun you have prepared. Ideally, you should place the model of the sun at the end of a long hall that has outside doors opening at the far end. Or place it on outside school wall or fence that faces the playground. You may also want to consider having students make the sun model. (See materials for directions.)

4. Ask students to predict how far Earth will be from the sun model. You may also want them to predict how far away the other planets will be. Using the information that Earth is 107 sun diameters from the sun, have the student teams mark off 107 diameters using their sun diameter strips from Step 2. Have one team of students keep track of the number of diameters as they are marked off. See the charts below for actual distances in both English and metric scales.

5. Along the way, have students identify the location of Mercury and Venus. You may have to make arrangements to leave your school grounds to reach Earth. Consider marking off the distance to Mars. (It will be about half again as far as Earth.) You will want to identify the locations of the other planets using familiar landmarks. One way to do this is to use a local map to show where planets would be located. Also, you may want to have students use the "Hansen Planetarium Solar System Fact Sheet" average distance from the sun to find the correct distances.

6. When you have established where Earth is located, have students predict where the moon would be. Students will expect the moon to be farther away than it is. In this scale, the moon would be approximately an arm's length (.83 inches x 30 earth diameters = 24.8 inches). From this model students can see just how close the moon is to Earth compared with the distance from Earth to the sun. Also, have students look back to the sun and note its apparent size. It should look the same size as the sun looks in the sky. (Never look at the sun directly, without a proper solar filter.)

Scaled Distances of Planets

Mercury Venus Earth Mars Jupiter Saturn Uranus Neptune Pluto								
104 yards	195 yards	269 yards	409 yards	0.8 miles	1.46 miles	2.9 miles	4.6 miles	6 miles
95.2 meters	177.9 meters	246.1 meters	374.8 meters	1280 meters	2350 meters	4728 meters	7407 meters	9728 meters
42 suns	78 suns	107 suns	164 suns	559 suns	1027 suns	2065 suns	3236 suns	4250 suns

7. In this part of the lesson students will figure out how large the other planets are relative to Earth and the sun using the same scale, Earth is a nickle. Have student teams predict how large the other planets will be in comparison to Earth. To do this assign each team a planet and give them a large double sheet of newsprint. Ask them draw and cut out a circle to represent how big they think their assigned planet is. Tape the models to the blackboard.

8. Now have the students make the correct size for their planet and compare them to their predictions. You may either give them the correct size for their model or have them calcuate the sizes of the other planets (See materials). If you are using the Standard III activity "Tour of the Solar System" you may want to coordinate it with this activity and have students make the planets for both activities. Consider whether to have the final models be two or three-dimensional.

Scale Size of Planets

Mercury	Venus	Earth	Moon	Mars	Jupiter	Saturn	Uranus	Neptune	Pluto
.8 cm	2.0 cm	2.1 cm	.6 cm	1.1 cm	23 cm	19 cm	7.7 cm	7.5 cm	.4 cm

9. Use a local map(s) to identify where the other planets would be located. You can make maps by going to http://maps.yahoo.com (See Materials). Have students orient themselves to the maps and locate the school, nearby landmarks, etc. Have students use scales on the map to locate where the orbits of the planets beyond Earth would be. This is a good time to help students understand that the planets are not in a straight line, but could be any where along their orbits. For fun, students may want to figure out if their own homes are located near one of the planet's orbit.

10. Discuss with students what they have learned from this modeling experience. Ask them to tell about new insights or things that surprised them. Have them record what they have learned in their science journals.

Possible Extensions/Adaptations/Integration:

1. Have students calculate the travel time to various destinations using different common travel modes such as walking time, car travel time, jet travel time, space craft travel time, or light travel time. First, have them estimate the time. Next have them calculate these times using the "Hansen Planetarium Fact Sheet 2002." For example, to determine spacecraft time from Earth, calculate the distance of the object from Earth in kilometers. Next, divide that distance by 40,000 km per hour (escape velocity for Earth, a minimum speed that spacecraft need to go). Compute the travel time in days by dividing by 24 and rounding to the nearest day. Compute weeks, months and years in a similar fashion. Students may also calculate how old they would be by the time they reached the destination. (See *Out of This World* by AIMS Education Foundation for many activities to help teach these concepts.)
2. Use different scales to recreate the solar system. Some ideas are listed below:

•Use the scale beginning with the sun as 1 meter. Calculate the sizes of the planets using the "Hansen Planetarium Fact Sheet 2002" for the relative ratios. This is the model used in the GEMS teacher's guide, *Messages from Space: The Solar System and Beyond.*

•Use the scale with Pluto represented as 1 mm. The sun would be represented by about 53cm. In this scale it is possible for students to pace off the distance to Jupiter. This gives them an understanding of just how far the distances to the outer planets really are.

3. Solar System Scavenger Hunt. Represent Earth with one spherical object, such as a ping-pong ball. Challenge students to find other objects or balls that are in the correct proportion to represent other planets.
4. Use modeling clay to show relative mass. Have students use the clay from a can of Play-Doh™ in this activity. Divide the clay into ten equal pieces. Next combine seven of the balls to represent the mass of Jupiter. Then combine two balls into one ball representing the mass of Saturn. Cut the remaining ball into two pieces that represent Uranus and Neptune. Any small pieces on the knife or left in the can are divided into five pieces representing the remaining five planets. The sun contains about 99.98 percent of the total mass of the solar system. It could be represented by a 13-gallon wastebasket filled with clay. You may want to decorate the wastebasket with a simulated Play-Doh™ label to cover the large bucket.
5. Play Solar System Smolf (smash + golf). The object of this game is to knock over water bottles (representing the planets) by throwing a tennis ball at them in the fewest number of throws. Partially fill nine water bottles with water (the more water, the more difficult to knock over). Using the length of the school playground as the distance to Pluto, estimate where each bottle (planet) should be placed. (See Background Information for the approximate ratios.) They do not have to be in a straight line since the planets are not in a straight line from the sun. Students begin at the sun and attempt to knock over Mercury. From Mercury they attempt to knock over Venus, and so on. Student teams count how many throws it takes to knock over all nine bottles.
6. Show relative distance from the sun to planets using adding machine strips. Give each pair of students a strip of adding machine tape. Together as a class, fold the adding machine tape to represent the following the various distances.

Label one end of the tape "sun" and the other end "Pluto." Fold the tape in half and label the fold Uranus. Fold each half in half again. The fold between Uranus and the sun is labeled Saturn and the fold between Uranus and Pluto is labeled Neptune. Fold the remaining paper in half between Saturn and the sun and label this fold Jupiter. Fold the remaining paper in half between Jupiter and the sun and label this fold Mars. Fold the remaining paper in half between Mars and the sun and label this fold Earth. Fold the remaining paper in half between Earth and the sun and label this fold Venus. Fold the remaining paper in half between Venus and the sun and label this fold Mercury.

Assessment Suggestions:

1. Have students look at printed models or commercial models of the solar system and determine what is correct and incorrect with the models.
2. Have students create a survey in which they use a model of Earth, such as a nickel, to find how accurate the perceptions are of other people concerning the relative sizes and distances in the solar system. Students compile and analyze their results.

Additional Resources:

Out of this World, AIMS, 1994.
This teacher's guide has many math and science connections for studying space. Blackline worksheets are provided for students' use. Some activities are "Planetary Scavenger Hunt," "Around the Planets," "Weight in Space," and "How Long Does It Take?" Available from AIMS Education Foundation, P.O. Box 8120, Fresno, CA, 93747, http://www.AIMSedu.org/, 1-888-733-2467

Learning Technologies, Inc. "Solar System Scale Model Kit." Students can use this inexpensive kit to make models of the solar system. A teacher's guide gives step-by-step directions for making models. The kit includes beads, two sizes of marbles, ping-pong balls, Styrofoam balls, two sizes of balloons and a miniature earth globe. Available from Project Star, Learning Technologies, Inc., 40 Cameron Avenue, Somerville, MA, 02144.

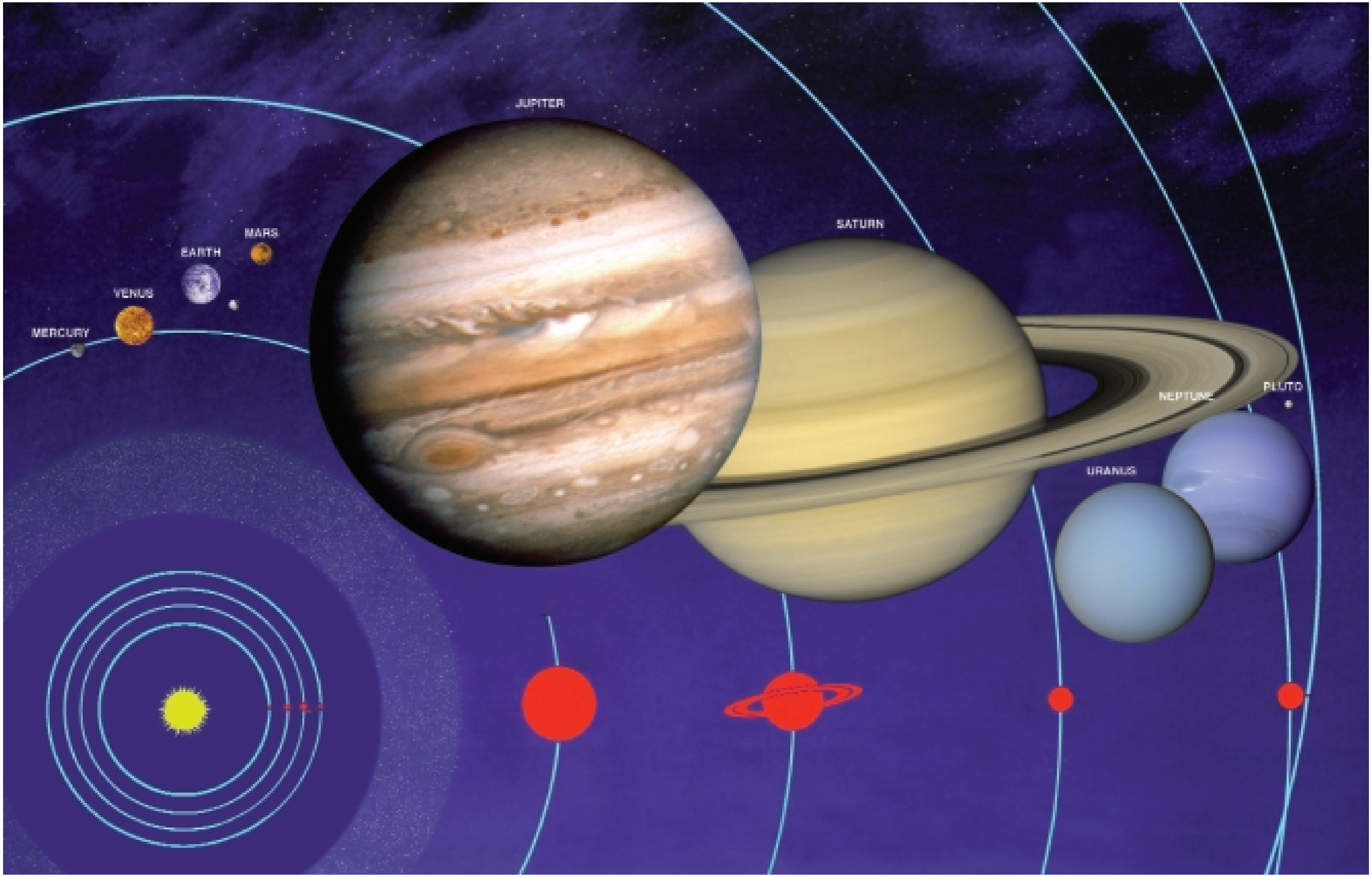
Marson, Ron. *The Earth, Moon & Sun*. Tops Learning Systems. 1993.
The activities in this guide include "Great Ball of Fire," "Paper Punch Moon," and "Paper Plate Sun," which teach about relative size and distance between Earth, the sun and the moon. It also includes activities that help explain other core standards. For grades 3-10. Includes worksheets and detailed lesson plans. TOPS Learning Systems, 10970 S. Mulino Road, Canby, OR, 97013.

http://www.exploratorium.edu/ronh/solar_system/index.html
This site assists you and your students in making a solar system in the correct scale. You just enter a size for the sun and it computes the correct sizes and distances for the model.

http://maps.yahoo.com
This website will help you make a local map if you type in the school's address. It has a zoom feature so that you can get a small map of the area around your school.

National Aeronautics and
Space Administration

Our Solar System



Science Benchmark: 06 :04

The sun is one of billions of stars in the Milky Way Galaxy, that is one of billions of galaxies, and the universe. Scientists use a variety of tools to investigate the nature of stars, galaxies, and the universe. Historically, cultures have observed objects in the sky and understood and used them in various ways.

Standard 04: Students will understand the scale of size, distance between objects, movement, and apparent motion (due to Earth's rotation) of objects in the universe and how cultures have understood, related to and used these objects in the night sky.

Objective 1: Compare the size and distance of objects within systems in the universe.

Activity 2: In a Galaxy Far, Far, Far, Far, Far Away

Intended Learning Outcomes:

1-Use science process and thinking skills

3-Understand science concepts and principles

4-Communicate effectively using science language and reasoning

Teacher Background:

The distances between objects in space are so incredibly vast that they are almost incomprehensible. Measuring these distances with the same measuring units we typically use for distances on Earth requires such huge numbers that they become meaningless. To help solve this dilemma, distances in space are measured using light units, or the time it takes light to travel a particular distance. The most common light unit is a light year: the distance light travels in one year. When distances are put into light units, smaller numbers can be used.

For example, the distance from Earth to the sun is about 93,000,000 miles. That's a pretty big number for the average person to comprehend. If the distance is expressed in light time, then the sun is about 8.33 minutes away from Earth. In other words, light from the sun takes 8.33 minutes to reach Earth. That is a little easier to understand than millions of miles. To get a feel for just how fast light travels, figure that light would be able to travel around Earth about 7.5 times in one second. The speed of light is about 186,000 miles (300,000 km) per second.

Light travel time not only includes the speed at which visible light travels, but also the speed of all energy in the electromagnetic spectrum, including radio waves. This explains why radio transmissions to objects in the solar system have a delay. For example, Mars is about 4.35 light minutes away from Earth. That means it also takes radio signals 4.35 minutes to reach Mars. It would take another 4.35 minutes to return a message. This delay makes it challenging to control robots and space vehicles on Mars with signals from Earth.

Light year is a measurement used to measure distances between stars and galaxies in space. Alpha Centauri is the nearest star to Earth; it is 4.3 light years away. Light years can also be used to describe the size of something. For example, the Milky Way Galaxy is 100,000 light years across.

Materials:

- meter sticks scaled in both metric and English measurement, one per pair or team of students • calculators, one per pair or team of students
- transparencies that you make from "Speed of Light" and "The Universe in Numbers" pages (see Appendix)
- Hansen Planetarium Solar System Fact Sheet (see Appendix)
- meter stick for each team of students
- local map extending 100 miles from your school. One nice way to get a local map is to use the Internet site http://maps.yahoo.com to create a map with your school at the center. The website offers a variety of zoom magnifications. You can put your school at the center of the map by adjusting the North, South, East, and West directional arrows.
- Utah map
- United States map

Invitation to Learn:

Show a clip from the movie *Star Wars* where Han Solo jumps his spaceship *The Millennium Falcon,* to light speed (about one hour into the film). Discuss: Is this possible? How long would it take even if it were possible? And/or

Discuss with students how things might be measured using different scales. Show students that using some units of measure are not practical. • Would you measure how long the playground is using millimeters? • Would you measure how long a book is by how many letters are in it?

- Would you measure how many chocolate chips in a cookie recipe by counting each chocolate chip?
- Would you say how old you are by using minutes?

Introduce the idea that distance in the universe is measured in light years. Explain that distances in space are enormous and that light years are a more practical scale than using kilometers or miles.

Activity A

Instructional Procedures:

In this activity students will review Astronomical Units or A.U.'s. They will use a meter stick as a comparison for the solar system. Then they will learn about distances in the solar system in light travel time. They will begin by learning how far objects in the solar system are in terms of light travel time. Then they will learn how far several familiar bright stars are from Earth.

1. Explain the following scale to be used in this activity. This activity assumes that students have had experience with the relative size and distance of objects in the solar system. Ideally it would follow the activity "How Big, How Far." Review with students that an Astronomical Unit or A.U. is the average distance between Earth and the sun. In this activity, a meterstick will represent the radius of the solar system.

2. Organize students in small groups. Have them use the information from the "Hansen Planetarium Solar System Fact Sheet" (see Appendix) or from the chart below to calculate where each planet in the solar system would be on the meter stick. Have students label where each planet is located on a meter stick.

Relative Distance of Planets:
Scale = 1 A.U. = 1 inch

Mercury	Venus	Earth	Mars	Jupiter	Saturn	Uranus	Neptune	Pluto
3/8 inches	3/4 inches	1 inches	1 1/2 inches	5 1/4 inches	9 5/8 inches	19 1/4 inches	30 1/8 inches	39 1/2 inches

3. Tell students that the star Alpha Centauri is the nearest star to the sun. Ask them to estimate how many miles away the star is. Alpha Centauri is about 26,395,632,000,000 miles away from Earth. Remind them that this is the closest star! Explain that distances beyond the solar system are so enormous that another measuring unit, light years, is needed to measure.

Sirius, the brightest star is over 50,000,000,000,000, miles away. Betelgeuse, the bright red star in Orion's shoulder is over 3,060,000,000,000,000 (3 quadrillion, 60 trillion) miles away. These huge numbers are incomprehensible.

4. Explain that light years are the distance that light travels in one year. Show the "Speed of Light" transparency (see Materials). Help students understand that light years are used because the large numbers are so unmanageable.

5. Describe some distances and time that light travels. For example light could travel the distance around Earth about 7 1/2 times in one second. It takes light about 3 seconds to travel from Earth to the moon and back. Light takes about 8.33 minutes to travel to the sun. Light from the nearest star takes about 4.22 years to reach Earth. Light left Alpha Centauri when the average sixth grader was about 7 or 8 years old. Alpha Centauri is not visible from the northern hemisphere. The nearest star visible in the northern hemisphere is Sirius. It is 7 light years away.

6. Organize students in small groups. Have them use the information from the "Hansen Planetarium Solar System Fact Sheet" (see Appendix) or from the chart on the next page to label the time distances on their meter stick (see Step 2). You may also have students make a graph showing the light travel time. Or you may want them to relate the various times to other times they are familiar with. For example, the time for light to travel to Pluto is about the amount of time students spend in class on a typical school day.

Light Time Travel from the Sun

Mercury	Venus	Earth	Mars	Jupiter	Saturn	Uranus	Neptune	Pluto
3^m13^s	6^m1^s	8^m19^s	12^m40^s	43^m16^s	$1^h19^m28^s$	$2^h39^m50^s$	$4^h10^m25^s$	$5^h28^m53^s$

7. Using the meter stick scale we have developed for the solar system: one light year equals one mile. There are 21 stars that are within 12 light years of our solar system. Seven of them are visible with the unaided eye. Only two of these are among the brightest stars (Sirius and Procyon). The other stars are red dwarfs and only visible with a telescope. Of the 15 brightest stars visible in the Northern Hemisphere, ten of them are within 77 light years. The other five stars are from 197 to 1467 light years away. (See the chart below.)

The Distance of the Fifteen Brightest Stars

Star	**Constellation**	**Actual Distance**	**Scale Distance 1 light year = 1 mile**
The Sun to Pluto		5.5 light hours	39.5 inches
Alpha Centauri*	(Southern Hemisphere)	4.5 light years	4.5 miles
Sirius	Canis Major	8.6 light years	8.6 miles
Procyon	Canis Minor	11 light years	11 miles
Altair	Aquila	17 light years	17 miles
Vega	Bootes	25 light years	25 miles
Fomalhaut	Piscis Austrinus	25 light years	25 miles
Pollux	Gemini	34 light years	34 miles
Arcturus	Bootes	37 light years	37 miles
Capella	Auriga	42 light years	42 miles
Aldebaran	Taurus	65 light years	65 miles
Regulus	Leo	77 light years	77 miles
Antares	Scorpius	197 light years	197 miles
Spica	Virgo	262 light years	262 miles
Betelgeuse	Orion	522 light years	522 miles
Rigel	Orion	773 light years	773 miles
Deneb	Cygnus	1467 light years	1,467 miles

*Alpha Centauri is not one of the ten brightest stars. It is included for comparison since it is the next nearest star to our solar system

8. Make copies of a local map that extends about 12 miles from your school for each student (See Materials). Have each group locate Alpha Centauri, Sirius, and Procyon. Use the Utah map to locate the stars within 77 miles. Use the United States map to locate the remaining stars. In this activity, the stars will not be plotted in their correct relative space from each other; just their distance from Earth. Students should realize that the stars are not in a straight line on the maps, but spread throughout space.

9. Discuss other distances in space. Use “The Universe in Numbers” overhead transparency to show the comparisons.

Activity B

Instructional Procedures:
In this activity students will learn how far objects in the solar system and in space are in various modes of transportation they are familiar with. They will gain an understanding of how big these distances really are.

1. Use an overhead transparency to show how long different travel modes would take to reach various destinations. Six different travel modes and four different locations are given. You may calculate more using the Hansen Planetarium Fact Sheet for the distance to different planets.
2. Students may calculate the distances and times themselves, figuring out how far they could travel at a certain speed in one year. You may have them work in small groups and figure the distance to different planets or stars.

<u>Possible Extensions/Adaptations/Integration:</u>
1. To help put the large numbers in perspective, relate it to things the students know. For example, twelve years (the birthday that most 6th graders celebrate) is about 379,000,000 seconds. In the

Hypothetical Travel Time for Modes of Transportation from Earth

	Walking	Biking	Car	Jet Plane	Space Shuttle	Voyager Probe
Average Speed	7 km/hr	25 km/hr	80 km/hr	800 km/hr	40,000 km/hr	56,000 km/hr
Distance in 1 year	61,320 km	219,000 km	700,800 km	7 million km	350 million km	490 million km
Time to Moon 384,400 km	6.27 years	1.75 years	6 months	20 days	9.6 hours	6.9 hours
Time to Mars 78,340,000 km	1278 years	357.7 years	111.8 years	11.2 years	81.6 days	58.2 days
Time to Pluto 5,766,200,000 km	94,000 years	26,330 years	8228 years	823 years	16.5 years	11.8 years
Time to Alpha Centauri 4.22 light years	652 million years	183 million years	57 million years	5.7 million years	109,000 years	82,000 years
Time to Sirius 8.6 light years	1.33 billion years	373 million years	117 million years	11.7 million years	233,000 years	167,000 years

3. Determine which modes of travel and which destinations you want to use for this activity. Make a blank chart with only the locations and modes of transportation. Make a second chart with the distances scrambled. (See sample chart at the end of this activity.)

4. Divide the class into teams of 2 or 3. Give each team a blank chart and a scrambled chart. Have students cut apart the scrambled chart and organize it in the correct order on the blank chart. A sample chart is included in the appendix.

same twelve years, traveling one mile a second (3600 miles per hour—more than six times faster than passenger jets travel), you would only be able to make two round trips to the sun (assuming, of course, that you could travel to the sun). Some other reference points:

- Christopher Columbus discovered America 16,125,933,000 seconds ago (calculated using time from 1492-2003.)
- The Declaration of Independence was signed about 7,164,000,000 seconds ago (calculated using time from 1776-2003.)
- You may calculate other time using the figure 31,557,600 seconds in a year (60x60x24x365.25.)

2. Phone home: Have students calculate how long it would take to contact the various planets. Radio waves travel at the same speed as light. See the chart in Extension 3.
3. Satellite Delay Relay: In this activity two students are "robots" on a distance planet who have to follow directions sent from "astronauts" for constructing a "space station." (This could be a pyramid built of paper cups.) The astronauts are permitted to send only one command at a time. You may want to consider putting in a time delay based on the light travel time to the planet. Students communicating with distant planets would have to send their messages over the course of several days. Explain that radio waves travel at the speed of light. That means that radio waves traveling from Earth to other planets have a time delay as they travel the long distances.

Light Time Travel from Earth

Mercury	Venus	Earth	Mars	Jupiter	Saturn	Uranus	Neptune	Pluto
5^m6^s	2^m18^s	0	4^m21^s	34^m57^s	$1^h11^m9^s$	$2^h31^m31^s$	$4^h2^m6^s$	$5^h20^m34^s$

4. Counting Stars: Have students simulate how stars are counted in the sky by using a sampling technique to count the number of symbols on a page of the Want Ads in a newspaper. Cut out 6 squares that are 4 cm square and randomly drop them on a newspaper page. Count the number of symbols in each square and find the average. Calculate how many symbols would be on the entire

page.

Assessment Suggestions: 1. Write a persuasive paragraph concerning whether space travel to distance stars is possible or not.

2. Calculate how long it would take to travel to a destination in the solar system or a star using different modes of transportation.
3. Show the Han Solo movie clip again from *Star Wars* used in "Invitation to Learn." Have students write whether they think the clip is realistic or not, and why.

Additional Resources:

AIMS. *Out of This World*. 1994. AIMS Education Foundation, P.O. Box 8120. Fresno, CA, 93747. Teacher's Guide with variety of math and science integrated space activities.

Project Haystack: The Search for Life in the Galaxy. SETI Institute, Teacher Ideas Press, Englewood CO. 800-237-6124. cation/Welcome.html" http://www.seti-inst.edu/education/Welcome.html

Simon, Seymour. *Galaxies*. 1988 and the *Universe*. 1998.
Both books have information written so students can understand enormous sizes and distances through comparisons. Full color photos.

Travel Time to Pluto

Mode of Travel from Slow to Fast	Average Speed	Distance Covered in One Year	Time to Get to Pluto

Travel Time to Pluto - Scrambled Data

8228 years	Jet	7 million km	40,000 km/hour
219,000 km	7 km/hour	94,000 years	Car
11.8 years	Bike	56,000 km/hour	700,800 km
Space Shuttle	490 million km	25 km/hour	16.5 years
Walk	80 km/hour	26,330 years	350 million km
823 years	800 km/hour	61,320 km	Voyager

Travel Time to Pluto (Answer Key)

Mode of Travel from Slow to Fast	Average Speed	Distance Covered in One Year	Time to Get to Pluto
Walk	7 km/hour	61,320 km	94,000 years
Bike	25 km/hour	219,000 km	26,330 years
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Space Shuttle	40,000 km/hour	350 million km	16.5 years
Voyager	56,000 km/hour	490 million km	11.8 years

SPEED OF LIGHT

186,000 MILES PER *SECOND*

300,000 KILOMETERS PER *SECOND*

11,160,000 MP *MINUTE*
18,000,000 KP *MINUTE*

669,600,000 MP *HOUR*
1,080,000,000 KP *HOUR*

16,070,400,000 MP *DAY*
25,920,000,000 KP *DAY*

112,492,800,000 MP *WEEK*
181,440,000,000 KP *WEEK*

5,865,696,000,000 MP *YEAR*
9,460,800,000,000 KP *YEAR*

11.2.23

THE UNIVERSE IN NUMBERS

THE MILKY WAY IS 100,000 LIGHT YEARS ACROSS AND 2000 LIGHT YEARS THICK AT ITS CENTER.

OUR SUN IS 30,000 LIGHT YEARS FROM THE CENTER OF THE MILKY WAY.

THERE ARE MORE THAN 100,000,000,000 GALAXIES IN THE UNIVERSE.

EACH GALAXY HAS BETWEEN 100,000,000,000 AND 300,000,000,000 STARS.

ANDROMEDA GALAXY IS THE NEAREST GALAXY TO OURS. IT IS 2,900,000 LIGHT YEARS AWAY AND 150,000 LIGHT YEARS ACROSS.

THE LOCAL GROUP CONTAINS 50 GALAXIES AND IS 5,000,000 LIGHT YEARS ACROSS.

Science Benchmark: 06 :04

The sun is one of billions of stars in the Milky Way Galaxy, that is one of billions of galaxies, and the universe. Scientists use a variety of tools to investigate the nature of stars, galaxies, and the universe. Historically, cultures have observed objects in the sky and understood and used them in various ways.

Standard 04: Students will understand the scale of size, distance between objects, movement, and apparent motion (due to Earth's rotation) of objects in the universe and how cultures have understood, related to and used these objects in the night sky.

Objective 2: Describe the appearance and apparent motion of groups of stars in the night sky relative to Earth and how various cultures have understood and used them.

Activity 3: Dot-to-Dot: Patterns in the Night Sky

Intended Learning Outcomes:

1-Use science process and thinking skills
2-Manifest scientific attitudes and interests
3-Understand science concepts and principles
4-Communicate effectively using science language and reasoning
6-Understand the nature of science

Teacher Background:

Constellations are patterns of stars visible from Earth in the sky at night. The stars in any given constellation form a pattern only as they appear from Earth and are usually many light years apart from each other. Although the positions of the constellations as they appear in the sky change over the course of a year, they are constant and predictable from year to year.

Many ancient civilizations organized the sky into constellation patterns. They associated these star patterns with stories or images of mythological creatures and heroes. The particular stars grouped into an individual constellation varied from one civilization to another. More than half of the constellations recognized today were identified by the ancient Greeks.

Constellations were more than just interesting patterns in the sky. The rising or setting of particular constellations was used to determine both the time of night and the season of the year. They were used to determine when to plant crops. Seafaring people used stars for navigation. Using stars for navigation continues today. As Earth revolves around the sun, the visible constellations change from season to season. Particular constellations are associated with the various seasons. Circumpolar constellations such as Ursa Major (Big Dipper) are visible throughout the year as they appear to revolve around Polaris (North Star).

Constellations are used as reference points on a star map to help people communicate with each other concerning the location of various objects in the night sky such as the moon, planets, stars, comets, meteor showers, etc. In 1930, the International Astronomical Union established eighty-eight constellations with precise boundaries.

Activity A

Materials:

- black craft paper, shaped in a large oval to cover a bulletin board (same shape as the opening in a star finder)
- smaller pieces of black craft paper or construction paper
- glow-in-the-dark stars, star stickers, or fluorescent markers or paint
- white or yellow string or chalk (optional) • graph paper, 1/4" squares
- books with myths and stories about the stars (See Appendix)
- transparency of a star finder map such as Uncle Al's Star Finder, available at http://www.lhs.berkeley.edu/starclock/skywheel.html

(Note: The Sky Wheel can be printed off free for teacher and student use. The copyright must show on it. Permission needs to be acquired from Alan Gould for distributing to students and other teachers. Email: agould@uclink.berkeley.edu

or

Star Finder, available from Learning Technologies, Inc., 59 Walden Street, Cambridge, Massachusetts, 02140, 1-800-537- 8703, $1.00.

Advance Preparation:

Using large pieces of black paper, lay out the background for a large star map on a bulletin board. Make an overhead transparency of a star finder such as Uncle Al's Star Wheel (see Materials) to project an enlarged image on the wall. The size you use will depend on the space available. Using the transparency as a pattern, construct three simple, easy-to-recognize circumpolar constellations: the Big Dipper, the Little Dipper, and Cassiopeia. Put each constellation on a single piece of black paper so that they can be moved throughout the year. Use glow-in-the-dark stars, star stickers, or fluorescent markers or paint to make the stars. Label each constellation and Polaris. (Polaris is the North Star—it will be the last star in the handle of Ursa Minor.)

Use the star finder as a guide to determine where you will place the constellations in their approximate correct positions for 8:00-9:00 p.m. in the current month, but do not put the constellations on the bulletin board yet. Plan to place Polaris in the upper center part of the star map (see star finder). Plan to change the position of the constellations each month. Also have enough room to add other constellations as they appear throughout the year.

Invitation to Learn:

Several days before you begin this activity place the replica of the constellation Cassiopeia (without its name) and the title "Mystery Constellation" in a conspicuous place in your classroom. Ask your students if any of them know what this constellation is, or where it can be found. Suggest that they try to locate it in the next few nights.

Instructional Procedure:

Since the positions of constellations and the particular constellations that are visible change through the seasons, students will gain a better understanding about the constellations if they are studied throughout the school year. This lesson describes activities that begin in the fall (when it is dark enough at 9:00 MDT and 8:00 MST to see stars) and continue throughout the school year. If that is not possible, the lessons may be taught in a shorter period with some adaptations.

1. Show students the replica of the Cassiopeia constellation again. Ask if any students have found this constellation. Show them the replicas you have prepared of the Big Dipper and the Little Dipper. Ask students if they have seen these patterns in the sky. Explain that these are constellations visible in the Northern Hemisphere. Their positions relative to Earth change over the course of a year. Place the constellations on the bulletin board in their correct positions. Locate Polaris and explain that it is also called the North Star because it always appears to be directly north. Its position is constant.

2. Use a pointer to outline the constellation figures on the bulletin board. Or if you prefer, use string or chalk to permanently outline the constellations. Tell at least one myth associated with each constellation. Ideally tell several myths from different cultures. (See Additional Resources) Tell students that they will be finding other things about the constellations in the following months.

3. Have students record the positions of these three constellations in their science journals. Challenge the students to find these constellations the following evening.

4. Discuss student observations in looking for the constellations. Talk about any particular challenges they faced. Depending on the time of year, the Big Dipper may be hidden behind mountains in some parts of Utah. Also, light pollution may affect visibility in populous areas. Have the students record observations in their journals.

5. Introduce two additional circumpolar constellations (Cepheus and Draco) to the students. Tell myths associated with these constellations or assign students to present the information. Add these constellations to the star map. Challenge students to locate these constellations in the night sky. The next day, discuss the student findings and place these constellations on the star map. Have the students record observations in their journals.

6. Help students become more familiar with these constellations by graphing them on grid paper. Use the following coordinates to help graph the constellations.
- Ursa Major: (M,37); (Q,34); (R,34); (U,33); (W,35); (Z,32); (X,30)
- Ursa Minor: (R,17); (O,18); (N,20); (M,22); (K,22); (L,25); (N,25)
- Cassiopeia: ((L,1); (K,4); (O,4); (S,5); (R,2)
- Cepheus: (G,6); (E,10); (I,12); (J,8); (O,11)
- Draco: ((B,33); (C,30); (E,32); (D,34); (B,24); (C,22); (F,24); (G,22); (G,28); (G;30); (I,31); (N,30); (R,27); (U,27)

Have students transfer their graphed constellations to their science journal and record information about each constellation.

7. Next have students make constellations to be used on the star map. You may have students choose the constellations or assign them. (See list below for possible constellations) Let students use the star finder transparency to make the constellations in the same scale as the classroom star map.

Have each team research the stories and myths associated with their constellation, identify any particularly bright star(s), and determine the time of year when the constellation will be visible at 9:00 P.M.

COMMON NORTHERN HEMISPHERE CONSTELLATIONS

The constellations are listed in the months when they appear high in the sky at around 9:00 p.m. Bright stars are in parentheses. For more constellations visit Michigan State website (see Additional Resources.) Many of these constellations are also visible in other months as well. Consult a star map for details. Circumpolar constellations such as Ursa Major, Ursa Minor, Cassiopeia, Cepheus, and Draco are visible throughout the year as they appear to revolve around the North Star.

<u>August - September</u> <u>October - November</u> <u>December - January</u>
Lyra (Vega)* Pegasus Orion (Betelgeuse and Rigel)
Cygnus (Deneb)* Andromeda Canis Major (Sirius)
Cepheus Cassiopeia Taurus* (Aldebaran)
Perseus

<u>February - March</u> <u>April - May</u> <u>June - July</u>
Gemini (Pollux and Castor) Ursa Major Bootes (Arcturus)
Canis Major (Sirius) Leo Ursa Minor
Ursa Major Virgo (Spica) Corona Borealis
Draco
Scorpius (Antares)

*Another common star formation is the Summer Triangle including the stars of Vega, Deneb, and Altair. Pleiades is a star cluster and part of the constellation Taurus.

8. Next have the students report on their constellations to the class. You may have all teams report at the same time, but consider having teams report over a period of time. That way they can report during the month when their constellation is most visible in the sky (at 9:00 p.m.). Also, if the constellations are introduced one at a time, it will be easier for students to keep them straight. Have each team place their constellation on the star map in the correct position.

9. One month later, ask students how the positions of the constellations have changed in the night sky. Challenge students to find out where the constellations now appear in the night sky. The next day readjust the constellations to their new positions. Use the star finder transparency to help you adjust the star map.

10. In the following month introduce any new constellations and reposition the star map. As the months progress, the positions of the constellations change. Discuss with students why different constellations appear. Help students understand that the constellations are constant, but as the Earth revolves around the sun, new constellations appear and others disappear. The constellations nearest the North Star are visible year round (although mountains may block their visibility during part of the night). These are known as circum polar constellations. The further south a constellation, the less time it is visible during the year in the Northern Hemisphere.

Activity B

Students make and use a star finder to help them locate constellations and stars in the night sky. This activity reinforces the idea that the apparent movement of constellations is caused as the Earth rotates on its axis, and that different constellations become visible during the year because the Earth revolves around the Sun.

Materials:

- star finders, such as Uncle Al's Sky Wheel, available at http://www.lhs.berkeley.edu/starclock/skywheel.html or available from Learning Technology, Inc., 59 Walden Street, Cambridge,Massachusetts, 02140, 1-800-537-8703, $1.00
- cardstock
- scissors
- tape

Instructional Procedures:

Plan for a star finder for each student. They may be purchased (See Materials) or made from a star finder patterns on cardstock. A good source is Uncle Al's Star Finder (See Materials). This activity may be used before Activity 1, if you choose, but it might be easier for students to do if they have some background knowledge about constellations.

1. Ask students what things are visible in the night sky and how can they find out what things are visible to them on particular nights. Explain that a simple star finder is a tool that can help them find some of the main things visible in the night sky.

2. Have students make their own star finders. Cut out the star map and star locator pieces according to printed instructions. Tape together star locator and insert star map.

3. Orient students to the parts of the star finder. If you have been doing Activity 1 with the students, they should recognize that the star map is similar. Practice aligning times on the star locator with dates on the star map. Identify stars and constellations that will be visible tonight at 8:00, 10:00, 12:00 midnight, etc.

4. Have students find the constellation of their astrological "sign." Also have them notice which constellations are not visible.

5. Ask questions to help students discover that the constellations that are visible will vary by date and time of night.

Questions to ask:
• What constellations are found in the sky in Fall? Winter? Spring? Summer? • What happens to stars during the day?
• Why do the constellations change from season to season?
• Are there any constellations that are visible during every season? Why?
• Are there any stars that do not seem to move?
• Why are some constellations not visible during some parts of the year?
• How is the sky different from 8:00 to 10:00? 12:00 midnight? 4:00 A.M.?

Possible Extensions/Adaptations/Integration:
1. Have a "star party" at night and use the star finders for locating constellations. Have students teach family members about the constellations using star finders. Arrange for telescopes and astronomers to help. (See Additional Resources.)
2. During a "star party," it is a good time to introduce some of the brightest stars. Teach students that the magnitude or brightness of a star depends on a combination of several factors: size of star, temperature of star, and distance from Earth. As students learn the names and locations of stars they will have a reference point for understanding the differences in sizes and distances of stars in the sky.
3. Make a Star Clock. This is a simple device that is used to determine the time by the location of stars relative to the North Star. The clock is rotated until the stars on the clock line up with the stars in the sky. A simple star clock is available on the same Internet site as Uncle Al's Star Finder (See Materials).

Star	Constellation	Color	Distance
Sirius	Canis Major	Blue	8.6 light years
Arcturus	Bootes	Orange	37 light years
Vega	Lyre	Blue white	25 light years
Capella	Auriga	Yellow	42 light years
Rigel	Orion	Blue white	773 light years
Procyon	Canis Minor	White	11 light years
Betelgeuse	Orion	Red	522 light years
Altair	Aquila	White	17 light years
Aldebaran	Taurus	Red	65 light years
Antares	Scorpius	Red	197 light years
Spica	Virgo	White	262 light years
Pollux	Gemini	Yellow	31 light years
Fomalhaut	Piscis Austrinus	White	25 light years
Deneb	Cygnus	White	1467 light years
Regulus	Leo	White	77 light years
Castor	Gemini	White	49 light years

4. Have students make constellation viewers using film canisters. The constellation viewer will have pinholes in the bottom to simulate seeing the constellation. These constellation viewers could be made and/or used at a star party.

Prepare constellation patterns that will fit within the circumference of a film canister lid. To do this, isolate constellation patterns on a star finder (see Materials). Reduce or enlarge the pattern if necessary. Next make reverse images of the constellations. Students cut out constellation patterns, place the reverse image pattern on the outside bottom of film canister, and tape it in place. Using a push pin, students poke holes through the stars on the pattern and the film canister bottom. Students can view the constellations by holding the canister toward a light source and looking through the open canister.

Another option is to have students research and complete an information box about the constellation on the viewer. The information box is taped around the outside of the canister or rolled up and put inside the canister for easy reference. The box should be a rectangle that measures ‘height by circumference” of the canister. Information could include how to find the constellation, when it appears in the sky, a description, myths associated with it, etc. Students may either wrap the information box around the outside of the canister and tape it in place, or roll up the information box and place it inside the film canister.

Sample Information Box

The Big Dipper, part of the constellation Ursa Major Northern Sky Best time to view: January – October Importance: The two outer stars of the cup point to the North Star The Big Dipper is a group of stars or an asterism that is part of the larger constellation Ursa Major (Big Bear). It is one of the easiest star groups to recognize because all seven stars are fairly bright stars and it is in the northern sky year round. The Big Dipper is useful because it helps locate other constellations. One version of a Greek legend says that Zeus' wife Hera was jealous of Callisto and changed her into a bear. Native Americans saw a bear (the dipper) being chased by three hunters (the handle). The second hunter is carrying a pot (a double star) for cooking the meat.

Assessment Suggestions:

1. Have students teach others how to make a star finder and explain how it works. For example, students could teach their parents or siblings how to make and use one at a star party in the evening.
2. Have students draw constellations and write what they have learned about them and stars in their journals.
3. Have students explain why the constellations visible at 4:00 or 5:00 in the morning are the same stars that will be visible in the evening four to six months later.
4. When students have made constellations or film canister viewers, organize a round robin and have the students teach their constellations to each other.

Additional Resources:

Heifetz Planisphere. Sturdy plastic star finder, principles and instructions printed on back. Available from Learning Technologies, Inc., 59 Walden Street, Cambridge, MA, 02140, (800) 537-8703, $9.95.

Night Star, advanced star map, soft, movable rubber, for more dedicated star gazers. 1334 Brommer Street, Santa Cruz, CA, 95062.

Star and Planet Locator, Edmunds Scientific, (800) 728-6999

Abrams Planetarium. http://www.pa.msu.edu/abrams

This Michigan State University site includes links to the Abrams Sky Calendars; a Sky Watcher's Page has many links to information on constellations, stars, planets, the moon, and more. It also has a list of constellations sorted by months.

Interactive Constellation and Star finder:
http://www.astro.wisc.edu/~dolan/constellations/

Lawrence Hall of Science, University of California at Berkeley. This site includes Uncle Al's star finder and Star clock as well as other links.
http://www.lhs.berkeley.edu/starclock/skywheel.html

Note: The SkyWheel can be printed off free for teacher and student use. The copyright must show on it. Permission meeds to be acquired from Alan Gould for distributing to students and other teachers. Email: agould@uclink.berkeley.edu

Dickinson, Terence. *Exploring the Night Sky.* 1998.
Good description of light time and relating it to objects in space, star distances, and constellations. Good pictures and photos. Text covers about half the pages. 72 pages.

Hinz, Joan. *Dot to Dot in the Sky: Stories in the Stars*. 2001
Excellent resource material for constellations. Describes fifteen common constellations; how to locate them, a myth that goes with each, interesting highlights, and scientific "space notes." 64 pages. $12.95.

National Audubon Society. *First Field Guide: Night Sky*. 1999.
Nice overview of all astronomy topics. About half the book focuses on finding objects in the night sky, 160 pages, pocket size paperback. $8.95.

Rey, H.A. *Find the Constellations*. 1976.
Excellent beginners guide to finding the constellations in the northern hemisphere. Well- illustrated, extensive index, glossary and timetable for sky viewing. A classic. 72 pages.

Rey, H.A. *The Stars: A New Way to See Them*. 1976.
"Clear, vivid, text with charts and maps showing the positions of the constellations the year round. One of the best books available for its purpose." It gives thorough descriptions and directions for locating constellations and their positions relative to each other. Many drawings and diagrams. 160 pages.

Thompson, C. E. *Glow in the Dark Constellations: A Field Guide for Young Stargazers*. 1989.
Simplified guide to constellations, describes how to find twelve common constellations throughout the year, includes a myth for each constellation. Illustrations have glow-in-the-dark ink to distinguish the constellation in the sky. 32 pages.

There are many amateur astronomy associations throughout Utah. Please check Hansen Planetarium's website for the most up-to-date information on the club nearest you.

To be Used With Activity A, Step 6

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z		
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Science Benchmark: 06 :04

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Standard 04: Students will understand the scale of size, distance between objects, movement, and apparent motion (due to Earth's rotation) of objects in the universe and how cultures have understood, related to and used these objects in the night sky.

Objective 2: Describe the appearance and apparent motion of groups of stars in the night sky relative to Earth and how various cultures have understood and used them.

Activity 4: Constellations: Pictures in the Sky

Intended Learning Outcomes: 3-Understand science concepts and principles

4-Communicate effectively using science language and reasoning

Teacher Background: Although stars in our night sky seem to be the same distance away from Earth, they are not. Most stars are trillions of miles away from Earth, and from each other. It's just that stars are all so far away that our eyes can't tell how much farther some are than others. Stars that form constellations are not usually close to each other.

Materials:

- three flashlights of the same brightness.
- a dark, large area (auditorium or lunch room)
- picture of Orion for each student
- picture of Orion (stars labeled with light years) for each student
- a piece of cardboard for each student
- seven beads for each student
- fishing line
- rulers

Invitation to Learn:

Ask students if they think stars in a constellation are close together or far apart. Have them base their opinions on observations they have made of the night sky.

1. Choose three students to represent three stars in the handle of the Big Dipper. Give each student a flashlight.
2. Have the rest of the class stand at one end of a long dark room.
3. Mark a line on the floor and have one child stand on it. He/she is Mizar (MY-zar) and is 78 light years away from Earth.
4. Have another student stand two feet to the left of Mizar, and two feet behind the line. He/ she is Alioth (AL-ee-oth) and is 81 light years away from Earth.
5. Have the remaining child stand five feet to the right of Mizar, and six feet behind the line. He/she is Alkaid (al-KAYED) and is 100 light years away from Earth.
6. Have Mizar, Alioth, and Alkaid turn on their flashlights and point them toward the rest of the group. Turn off lights in the room.
7. Ask the students what they notice about the stars. Do the stars appear to be the same distance away? (The stars should appear to be close to each other). Why do the students think this happens? 8. Explain to the students that because stars are so far away from Earth, they appear to line up in the sky and form constellations. Mention that the stars in the Big Dipper are closer to each other than most stars are in other constellations.

Instructional Procedures:

1. Hand out both pictures of the Orion constellation. 2. Have students glue the first picture (the one that isn't labeled) to a piece of cardboard and poke holes in the seven biggest stars in the constellation.
3. Tell them to look at the second picture and pay attention to how many light years away each of the stars are from Earth.
4. Hand out fishing line and seven beads to each student.
5. Explain to students that they are going to use fishing line and beads to represent the distance from Earth for each star in the Orion constellation. Explain to students that the star with the least amount of light years will have the longest string because it is closest to Earth. Stars that are the most light years away from Earth will have the shortest string. 6. Tell students that instead of measuring with light years, they are going to be using centimeters. Have students figure out what length of fishing line would represent each star.
7. Have students place the appropriate length of string in the holes they made for each star. Tape the string to the back of the cardboard.
8. Have them tie a bead on the end of each string. The bead represents the star.
9. Hang the finished products on the ceiling so students can see that stars in a constellation are not all the same distance from Earth.

Assessment Suggestion:

Put students in groups of three. Have each member discuss his/her observations of the activities. Walk around the room and clear up any misconceptions the students may have.

Additional Resources:

Dickinson, Terence. *Exploring the Night Sky*. 1998.

Good description of light time and relating it to objects in space, star distances, and constellations. Good pictures and photos, text covers about half the pages. 72 pages.

National Audubon Society. *First Field Guide: Night Sky*. 1999.

Nice overview of all astronomy topics. About half the book focuses on finding objects in the night sky, 160 pages, pocket size paperback. $8.95

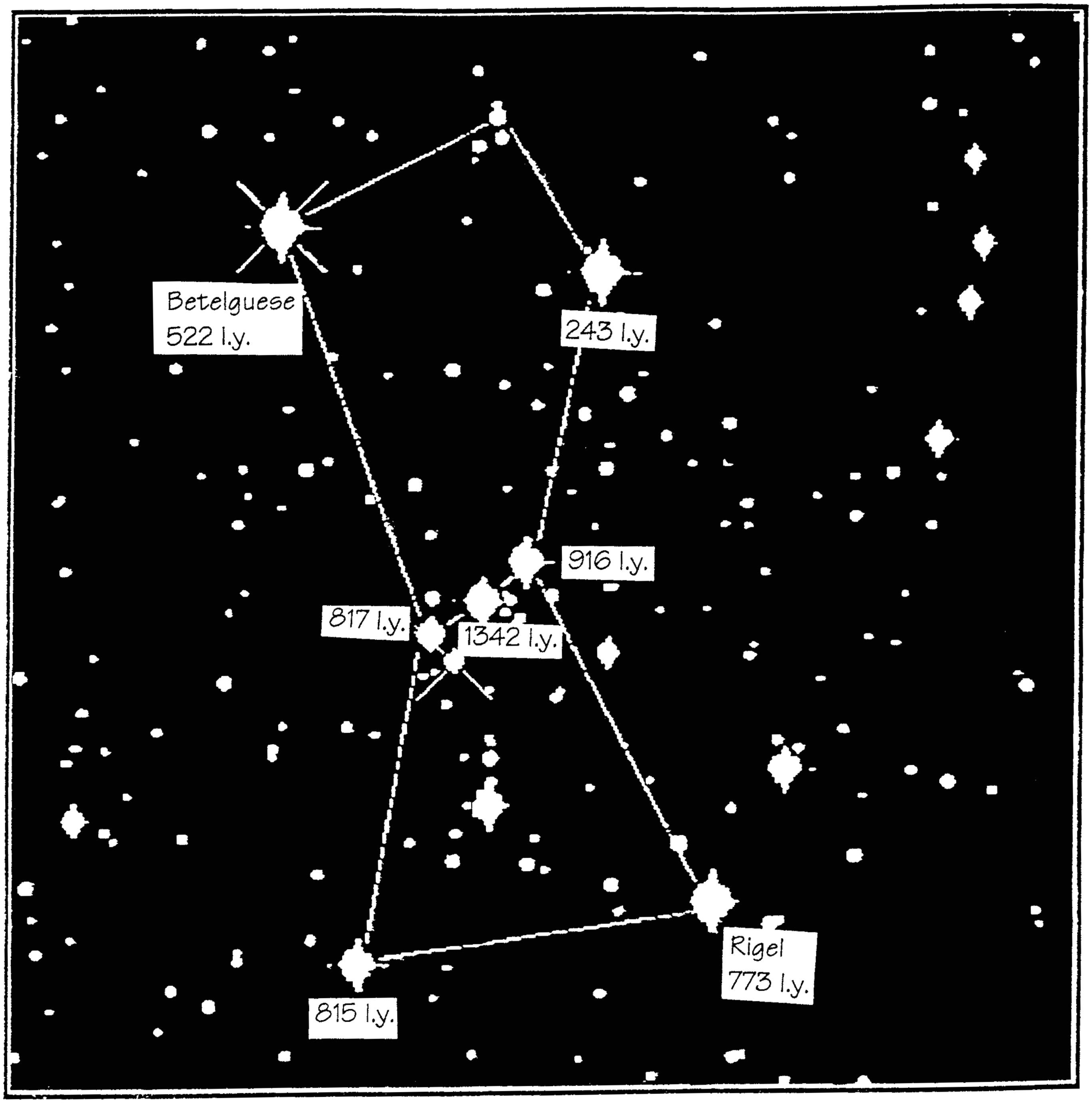
The following books cover a variety of astronomy topics about the sun, moon, planets, stars, constellations, and space travel.

Hawkes, Nigel. *Mysteries of the Universe*. 1995.

Lambert, David. *Stars and Planets*. 1994.

Miles, Lisa and Alastair Smith. *The Usborne Complete Book of Astronomy & Space*. 1998.

Muirden, James. *Visual Factfinder: Stars and Planets*. 1993.


Betelguese
522 l.y.
243 l.y.
916 l.y.
817 l.y.
1342 l.y.
Rigel
773 l.y.
815 l.y.